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Environment Ontario legacy

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Brock A. Smith appointed Deputy Minister of the Environment

Brock A. Smith was appointed Deputy Minister of the Ministry of the Environment in January 1984. Before his appointment, Mr. Smith had been Assistant Deputy Minister, Office of the Budget, Ontario Ministry of Treasury and Economics.

Born in Sudbury, Mr. Smith attended the Copper Cliff High School and earned a Bachelor of Commerce degree at McGill University. After working for two years with McLeod Young Weir Ltd., he returned to McGill for a Masters degree in Political Science.

In 1969 he joined the Ministry of Treasury and Economics as an executive assistant followed by a number of years as an economist with the Taxation and Fiscal Policy Branch. He spent five years with Treasury's Office of Economic Policy, serving as Director of Economic Policy and then Director of Economic Development.

In 1978 Mr. Smith returned to the Taxation and Fiscal Policy Branch as Director.

In 1980 he transferred to the Ministry of Industry and Tourism, serving first as Executive Director of Policy and Priorities and then Assistant Deputy Minister for Industry. In late 1981 he returned to the Ministry of Treasury and Economics as Assistant Deputy Minister, Office of the Budget.

Mr. Smith enjoys golf, tennis and fishing in summer and skiing and curling in winter.

He is married, has four children and lives in East York.

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Ministry of the Environment
Ontario

Hon. Andrew S. Brandt, Minister

Brock A. Smith, Deputy Minister

Environment Ontario legacy

Winter 1983/84 Vol. 12, No. 1-2

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Editor .....Robert Koci
Director of Communications Branch.....R.J. Frewin

Following his appointment in July 1983, Ontario's Minister of the Environment Andy Brandt travelled widely to discuss environmental issues with as many people as possible. Our cover reflects a variety of Mr. Brandt's activities including: (clockwise from top left), signing of the Ontario-Minnesota agreement for cooperative action on acid rain with Saundra S. Gabering of Minnesota's Pollution Control Agency in Grand Portage, Minn.; visiting an acidified lake and an Environment Ontario research station studying the effects of acid rain on forest soil; a TV interview; inspecting air quality monitoring equipment with Robert Kaplan, Canada's Solicitor General and Jim Raynolds and Ed Rygiel of Sciex Ltd.; a tour in Sudbury with Associate Deputy Minister J. Walter Giles, Rob Butler of Inco and Ministry regional director Bill Gibson; and (centre) discussing environmental problems with young Ontarians. (photos: Tessa Buchan, Hans Eijsenck, cover design: Hugh McCall)

CONTENTS

Blueprint for Waste Management

Ontario is ready for sweeping changes

The public hearings held in the Orillia town council chamber were attended by many representatives of municipalities in the Muskoka-Haliburton area. (photo: R. Koci)

Ontario is ready for sweeping changes in the management of its wastes. That is the message Environment Ontario gained from about 300 submissions it received in response to its unique project designed to involve as much of the public as possible in its Blueprint for Waste Management.

Ministry executives and waste management experts staged 83 public meetings in July, August, September and October in all parts of the province as part of the ministry's major public information program mounted to support the Blueprint and to generate development of a final plan.

After 16 gruelling weeks of travels, presentations, and of asking and answering countless questions, all participants agree that the public information program was an unqualified success.

The forums have shown that some proposals of the Blueprint are accepted generally and may be realized without undue delay. Others will need more study and more involvement of municipalities, industry and the public, and will be phased in gradually. At this time it is evident that the Ontario public has accepted the challenge to help with the problem of the management of waste.

Nearly 5,000 municipal employees, representatives of industry and environmental organizations and interested members of the public participated in the meetings.

Many thousands more were introduced to the ministry's effort through discussions generated by media reports, in municipal council and association meetings and internal discussions in industrial waste management operations.

The public involvement project started with 43 meetings held in July and August. At these meetings members of municipal councils and works departments, of environmental associations and waste management industry operations were familiarized by slide shows and verbal presentations with Environment Ontario's Blueprint for Waste Management.

Specific questions on the intent of the Blueprint were discussed and answered. Dialogues between ministry representatives and participants at the meetings clarified the Blueprint's central "four R" concept and the ministry's objectives.

Environment Minister Andrew S. Brandt attended a number of the meetings held with municipal councils and staff, at which the ministry's Waste Management Branch Director, Ron Gotts, and branch experts Tom Armstrong, Bill Balfour and Boris Boyko made presentations and answered questions.

In addition, 17 public information meetings were held in strategic locations at the request of municipalities or where the need for them became evident.

Three separate, in-depth, full-day workshops were arranged at the request of citizen groups and industry.

In September and October, a panel led by Associate Deputy Minister J. Walter Giles toured Ontario to stage 20 public forums to gather ideas and proposals in response to the Blueprint. The forums followed the initial information meetings held in July and August as a means of assisting groups, individuals and agencies in preparation of submissions.

These public forums were held in 20 Ontario communities from Cornwall to Kenora and from Timmins to Windsor. Two days of hearings were held in Toronto.

Two sessions were held in each community, one in the afternoon and one in the evening. Most meetings were well attended and valuable written and oral suggestions were received from municipalities and the general public. More than 1,100 people attended these sessions and 158 submissions were presented.

Environment Ontario's public forum team consisted of Tom Armstrong, the Blueprint coordinator, Ron Gotts, Boris Boyko, Bill Balfour, and Gulu Uppal of the Waste Management Branch. The team was assisted by Ginny Whitten-Day and Murray Cheetham of the Communications Branch, who coordinated all meeting and travel arrangements.

Mr. Giles, who chaired all the forum meetings, summed up the general results of the public information program: "People showed significant interest all across the province. I was especially impressed by the submissions received from some municipalities which obviously had studied the Blueprint intensively and introduced several very interesting suggestions."

Mr. Giles also found the "four R philosophy" — reduction, reuse, recycling and recovery — already being applied in some municipalities while in others opportunities for the realization of the concept must still be created.

"Generally, we met with a uniform agreement with the Blueprint concepts," he said. "It is now our job to analyze and weigh all the input we have received and to incorporate it in the final plan for waste management in Ontario."

Mr. Brandt's office has received more than 300 submissions including the 158 presented to the ministry panels at the 20 forums.

The preliminary indication is that most submissions support ministry proposals in general but some specific areas have been highlighted for intensive follow-up examination.

All presentations, as well as questions arising from the forum proceedings, have been electronically recorded and the record as well as the written submissions are now being studied by ministry experts. Assessed and closely analyzed, the submissions will provide a valuable contribution to the final recommendations on waste management to be made to the minister.

New legislation widens municipal powers

The Ontario Water Resources Amendment Act, 1983 (S.O. 1983, c.51) and the Environmental Protection Amendment Act, 1983 (S.O. 1983, c.52) were passed by the Ontario Legislature and received Royal Assent on November 9, 1983.

The EPAA protects employees who assist in the enforcement of environmental legislation. It also gives the Ontario Labour Relation Board the same powers the Board has under the Labour Relations Act to protect employees from reprisals for assisting in the enforcement of the EPA, OWRA and other environmental legislation.

The EPAA also empowers a director to issue orders to prevent pollution and to lessen the effects of discharges by requiring that equipment and personnel be available and appropriate measures be implemented.

The OWRAA enables the Minister of the Environment to give municipalities certain powers of approval. This will reduce costs and delays related to certain approvals.

The OWRAA provisions dealing with rates are also expanded and the rights of municipalities to question new rates or charges for sewage or water works are protected. The Act also clarifies the powers to regulate wells and well drillers, and provides benchmarks that can be used to test the willingness of a company to proceed with abatement programs.

The wording of Part VII of the EPA, dealing with septic and other systems, is simplified. Persons whose property is seized by a Provincial Officer under the EPA obtain the right to a judicial review of the continued detention of the seized property.

Both Acts establish a new procedure for appeals to the Environmental Appeal Board. They simplify hearings and enable the Appeal Board to require that provisions of an Order be complied with pending the outcome of an appeal.

Director, SE Region

DONALD N. JEFFS has been appointed director, Southeastern Region.

Mr. Jeffs joined the Ontario Public Service in 1960 after working as a geological engineer in mining development and production operations in Canada and the United States. He worked initially as a hydrologist with the Ontario Water Resources Commission and has occupied supervisory positions in both ground water and water modelling sections and was a member of the International Reference Group on Great Lakes Pollution from Land-use Activities under the International Joint Commission.

On appointment as director of the Water Resources Branch, he assumed responsibility for the direction of programs to provide resource information and water management recommendations to protect water quality and ensure its availability for a wide variety of uses.

Environmental Assessment Advisory Committee

To broaden the extensive public input to environmental assessments, the Ontario Minister of the Environment formed an Environmental Assessment Advisory Committee.

Chairman of the new committee is Marie Corbett, Q.C., a Toronto lawyer in private practice. Committee members are S.A. Monte Hummel, Executive Director, World Wildlife Fund (Canada) of Cookstown, and Lorne Maeck, former Ontario Cabinet minister, of South River, Ontario.

The mandate for the Advisory Committee on Environmental Assessment is:

1. To provide advice to the government through the minister of the environment in matters relating to requests for exemptions from the provisions of the act, and to requests, or proposals for the designation of undertakings so as to render them subject to the act;

2. To advise on, and comment on, the reasons provided by the proponent for the exemption of an undertaking, in particular those reasons relating to public health and safety, economic necessity and significance of environmental effects;

The procedures of the committee will be reviewed by the minister at the end of the first year of operations.

Marie Corbett, Q.C., specializes in administrative law, predominantly pension law and planning and environmental law. Called to the Ontario Bar in 1970, she has been in private practice since 1980. She has served as a lawyer with the City of Toronto Legal Department.

Solon Lamont (Monte) Hummel, executive director of the World Wildlife Fund (Canada), enjoys an outstanding career in conservation and environmental activities. He currently is chairman, Pollution Probe Foundation; member, Canadian Environmental Advisory Council.

Lorne Howard Maeck, a native of South River, was elected to the Ontario Legislature in 1971 as MPP for Parry Sound and was re-elected in 1975 and 1977.

He served as Parliamentary Assistant to the Ministers of Natural Resources and Education and was appointed Minister of Revenue on January 21, 1978. He served in that portfolio until 1981, when he retired from politics.

Federated Health-Campaign 1984

The Federated Health Campaign is a new name for a fund-raising effort that was called the Cancer-/Heart Campaign or, in 1983, Cancer, Heart, Diabetes Campaign.

The name change reflects the expansion of the campaign to include four additional organizations, each with a long history of caring and helping.

The organization joined in the 1984 campaign are:

The Lung Association, an organization that concentrates on problems such as asthma, emphysema and chronic bronchitis.

The Canadian Paraplegic Association, an association that helps adults disabled by spinal cord injuries to recapture a productive lifestyle,

The Canadian Hemophilia Society, founded in 1953 to help sufferers of the incurable disease to cope with their problems.

The Kidney Foundation, formed to support research in the causes, prevention, treatment and cure of kidney diseases.

Diabetes Canada, committed to finding a cure for the disease.

The Canadian Cancer Society emphasizing since 1938 that cancer can be beaten.

The Ontario Heart Foundation, devoted to a reduction of one of the major causes of death, heart attacks, stroke and circulatory diseases.

Our name is new–
the need is not!

Federated
Health
Campaign
Together for life.

$1 million for carbon filtration

Significant improvements introduced during the past few years in the ability to detect contaminants at very low levels — in parts per trillion and parts per quadrillion — have shown that there are undesirable contaminants in some of the waters used in Ontario to produce treated drinking water. Environment Ontario scientists are studying a variety of ways and means to efficiently remove such contaminants during the drinking water treatment.

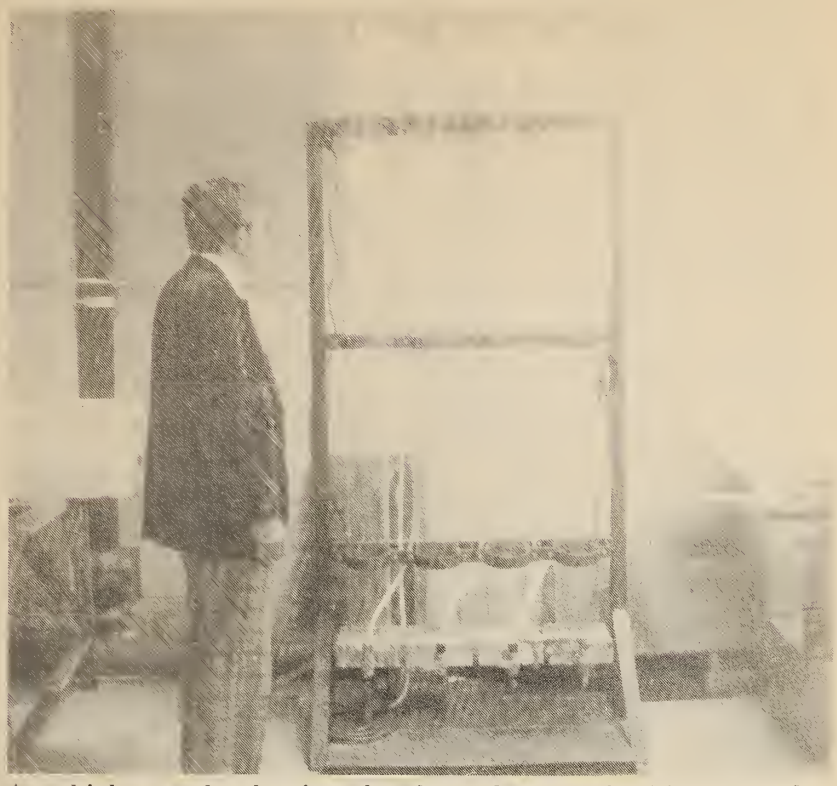
Some of these studies concentrate on the improvement of existing water treatment methods by the use of prechlorination, of ozone, or by the use of new coagulants.

One of the newest projects in the continuing search for better water treatment methods is a $1 million study designed to determine the efficiency of granulated activated carbon (GAC) for the removal of a wide variety of undesirable organic contaminants.

The excellent filtering abilities of GAC have been well know to chemists for a long time. GAC is actually used for the removal of odors and undesirable taste from water in two plants in Ontario and in many water treatment plants in Europe and in the U.S.

But while there are many reports on the ability of GAC to remove certain single compounds from liquids, very little is known about how GAC can deal with a wide variety of organic compounds at the same time. Each of these compounds may have different characteristics as to their volatility, solubility, or molecular weight.

What happens in the GAC filtering process is that individual molecules collect and concentrate on the surface of the granules, and there are indications that some of these molecules may react with others to produce compounds that may be less desirable than the original ones. GAC can also act as a good breeding ground for bacteria.



A multiple granulated activated carbon column awaits shipment to the Niagara Falls study site. (photo: R. Koci)

In the new project, a pilot plant using GAC will be added to the Niagara Falls water treatment plant. This pilot plant, consisting essentially of several columns filled with GAC, will allow the investigation of effects of various coagulants used in water treatment, of the pH of the treated water, of other parameters on GAC, and on the removal of contaminants.

It will also help scientists to determine the best depth of the GAC bed needed to remove certain contaminants, the effects of water pressure on the bed, and other operating details. The GAC treated water will not be mixed into the drinking water distribution system.

One of the challenges the study is facing is the evaluation of the large number of samples that will have to be analyzed for a number of contaminants that may be present at very low levels. To allow a useful evaluation, the samples will have to be taken not only frequently at the water intake and at the exit of the column, but also at various locations within the GAC column. In addition, the carbon in the columns must be analyzed regularly to gain an insight into its efficiency and its effects on the various contaminants.

The GAC study will take up about three years. The study will complete a three-stage Environment Ontario research program in drinking water treatment technology.

The first stage of this research program involved a $210,000 study of ozonization. The second dealt with the use of new coagulants for the removal of trace organics. The third focuses on the possibility of improving existing treatment processes and the benefits possible by the addition of GAS absorption to water treatment.

The goal of all these research studies is to ensure that the most efficient and effective water treatment processes are made available to the citizens of Ontario.

Breaking the "parts per quadrillion" barrier

By Robert Koci

Environment Ontario's main laboratory in Rexdale has increased its detection capability to measure dioxins in water one thousand fold and has become one of the few facilities in North America testing at a detection limit of 10 parts per quadrillion.

A quadrillion — written as 1,000 000 000 000 000 or 10^{15} — is a thousand trillions or million billions. But whichever way it is written it is an amount that lies well beyond the realm of everyday imagination.

One part per trillion (1 ppt) can be compared to one second in 33,000 years. On this scale, one part per quadrillion (1 ppq) can be compared to one second in 33 million years.

Environment Ontario's dioxin analysis group consists of three separate work units within the main facility geared to the analysis of dioxins in water, fish and other aquatic animals, incinerator emissions and process samples.

In the dioxin facility, all samples are analyzed for the presence of dioxin at the ppt level for fish and incinerator samples or at the ppq level for waters using the laboratory's new high-resolution mass spectrometer.

In analyses at the ppq level, it is not always possible to determine specifically which of the 75 dioxin and 135 furan isomers are present in the sample. Such an assessment is based on the comparison of the computer-produced graph of the sample with one resulting from the analysis of a standard solution containing a precisely known amount of the isomer. Standard samples for all the dioxins and furans are not yet available.

One of the current tasks of the dioxin group is to analyze raw and treated waters from 17 water treatment plants situated along the shores of Lake Ontario between Niagara Falls and Oshawa, Helle Tosine, supervisor of Environment Ontario's dioxin facility, said.

Working at full capacity, the water unit of the dioxin facility can process samples from two test sites every second week.

Dioxin analysis is very time-consuming — partly because of the elaborate procedures (protocol) that must be followed to assure the validity of the results, and partly because of the size of the samples.

At each sampling location, two 12-litre samples of raw water and two 12-litre samples of treated water are drawn. In addition, one or two 12-litre batches of distilled water previously proven to be dioxin-free are exposed to the air in the sampling room. This water is also returned to the laboratory to determine whether dioxins or furans were present in the air of the area where the sampling was carried out.

At the laboratory, the water samples are mixed with a specific solvent that extracts dioxins from water. The solvent is then removed and distilled.

further improvments are studied

The resulting small amount of extract is passed through a clean-up column of filtering material to remove interfering organics. This 'cleaning' process reduces the sample to about 10 microlitres — an amount that would just about wet the bottom of a teaspoon. Two microlitres are then injected at a time into the mass spectrometer for final analysis.

The mixing of sample water and solvent, the extraction of the solvent and the distillation takes about 20 hours. The filtering of the greatly reduced sample through the clean-up column takes about two days. Mass spectroscopy and the evaluation of the raw water takes up another day.

Usually the samples collected at two sites run through the process at one time. All samples are duplicated to ensure that the analysis can go on even if one set is damaged in transit, and to ensure that findings can be confirmed. If dioxins or furans are detected, a sample is sent to the National Health and Welfare Department in Ottawa for confirmation.

The procedure used in the analysis of dioxins in incinerator source samples and fish is similar. Fish flesh is macerated and liquified before processing. When incinerator stacks are sampled the stack gases are passed through filters, through certified clean water and through adsorbent traps. The contents of the filters, the water and the traps are then analyzed.

In addition to the ongoing analyses, Environment Ontario's dioxin laboratory is searching for ways to simplify or speed up its analytical procedures without endangering the validity of the analyses. In a colloborative research project now under way with the University of Waterloo, researchers are studying the possibility of filtering the water samples at the sampling site through a glass and polymer container, in which dioxins, if present, would be adsorbed by the filter medium.

At the laboratory, the contaminants could then be removed by an appropriate solvent. This would eliminate the transport of large amounts of water samples, and simplify the time-consuming mixing and extraction process.

There are several reasons for the search for dioxins at the ppq level. One of them is the suspected extreme toxicity of the substance.

The determination of its presence at very low levels will also help in the precise establishment of its source and its spread in our environment.

Currently there are no standards for dioxins in water. In fish an interim dioxin tolerance level of 20 ppt has been established by the Canadian Department of National Health and Welfare.

By developing the capability of detecting and measuring infinitesimally small quantities of contaminants such as dioxins, Ontario is assured of an early alert system.

The fourth part of a water sample - 12 litres filled into 12 clean bottles - starts out on its way through the analytical process at Environment Ontario's dioxin laboratory. (photo: Tessa Buchan)

Acid rain

Five-year liming study starts

By Susan Watson

Around noon on Thursday, August 11, a small group of scientists and organizers watched a large, orange aircraft buzz Bowland Lake, north of Sudbury, in an Environment Ontario experiment on the effects of liming on lake life.

Approaching from the north, the twin-engine Canso aircraft skimmed the water, dipped over trees, and released a long, white stream of limestone. A large, fog-like cloud was left settling into the lake. From the air, the streaks on the water looked like the fingers of an outstretched, skeletal hand.

The first drop was near the shore, and some lime drifted onto trees and rocks at the water's edge, creating a Christmas card scene.

Successive drops were more accurate as the pilots, in radio contact with a crew on the lake, covered a grid map devised by the co-ordinators of the study, Booth Aquatic Research of Toronto. Altogether, 85 metric tonnes of fine limestone powder were dropped into the lake.

The limestone was delivered by truck to Sudbury airport, where it was blown into the hold of the Canso through a large tube. Pilot Joe Reid said the finely-ground limestone performed just like water, as long as it wasn't packed too tightly.

That evening, the technicians ventured onto the lake to start the first round of sampling. The areas where lime was dissolving had the pale-green luminosity of ice.

Both physical and chemical environmental tests were done throughout the water column. Physical characteristics such as light penetration, conductivity (which indicated the amount of dissolved lime in the water), and temperature were documented. Samples were collected for chemical analysis at a mobile lab, a short portage and boat ride away on Laundry Lake.

Lewis Yeager, one of the technicians sampling on the lake, emphasized the importance of the nearby mobile lab: "The sample will be analyzed as quickly as possible. Some of the materials we look at in the tests cannot stand storage, trans-

The Canso twin-engined aircraft releases its load of pulverized lime onto Bowland Lake. (photos: Tessa Buchan)

portation or changes in temperature, so it's vital that we sample and analyze as quickly as possible."

At the lab, scientists wearing cut-offs and muscle shirts in the August heat, tested the samples for calcium content, pH and alkalinity. Results after four days of liming showed that the pH of Bowland Lake rose from 4.9 to 6.8 (7 is neutral), the exact target that the scientists had been aiming for.

Tom Brydges, of Environment Ontario's Acidic Precipitation in Ontario Study, squinted at the sunlight on the unnaturally clear waters of Bowland Lake and discussed the ultimate goal of the study: "We hope that this experiment will put us in a position to be able to use the liming tool ourselves, and to allow a cottage association to use it in an effective and environmentally safe manner."

He felt that if a cottage association were faced with the alternatives of se-

Finely ground limestone is used as neutralizing agent.

eing its lake acidify or liming it, it might choose the lime.

Doug Dodge, representing the Ministry of Natural Resources, co-sponsor of the study, was blunt about the consequences of total acidification: "If you accept the stock concept as a basis for managing animal populations, then when you lose a gene pool you have irretrievably lost a set of genes that cannot be replaced." Dr. Dodge emphasized that even if a lake were to be restocked, the new trout wouldn't have the genetic adaptions developed over thousands of years by the original species.

Faced with the harsh reality that abatement programs may not solve the problem of acid rain for another five to 15 years, scientists are investigating ways to protect dying lakes in the interim.

The theory behind neutralization is simple, but a sensitive aquatic environment has many variables which have to be taken into account.

The five-year study, co-ordinated by Booth Aquatic Research of Toronto, aims to arm scientists with biological as well as chemical information.

To reach these objectives, the experiment was divided into several phases: First, lakes meeting certain scientific criteria were selected. Then the chemistry, biology and hydrology were characterized. Next came the actual liming process itself and the analysis of immediate results. Last, the biological effects over the long term will have to be monitored and evaluated.

three lakes are chosen

In all, three lakes were chosen for experimentation. Bowland Lake, which no longer supports a trout population, was designated for whole-lake liming. Miskokway and Trout lakes, which are acid-stressed, are scheduled for partial liming.

Bowland Lake was chosen for several reasons. Most important was that background information was available on the history of fishing in the lake. As there are no cottages on the lake and access is limited, the number of variables in the experiment is minimal.

Bowland Lake is also a typical example of an acidified lake. It was once home to a thriving lake trout population, but now only contains about 100,000 yellow perch and other smaller organisms.

For the experiment, limestone, rather than slaked lime or quick lime, was used, since it would give a slower, more stable rise in pH. It was crushed finely so it would dissolve quickly, instead of settling out on the bottom of the lake.

The potential of the experiments was perhaps best summed up by Tom Brydges: "It's quite possible that the number of lakes that would ultimately be limed might be in the range of a few hundred ... Certainly not on a wide, broadscale approach. It's not practical, it's not desirable, and hopefully, and I suppose the critical thing is ... it will not be necessary. We hope that abatement at the source will bite in and affect things soon enough."

The Canso, a versatile aircraft used for water bombing of forest fires, receives its cargo of pulverized lime.

Bowland Lake, 70 km north of Sudbury, is one of the lakes chosen for the liming experiment. There are no cottages along its shores, and its water suffers from the effects of acid rain.

PET and LIS permit analysis of 1.5 million samples yearly

By John Korchok

In the course of a year, Environment Ontario's central laboratory in Toronto analyzes about one and a half million samples — or 7,500 samples per working day — of water, air, fish flesh, and a wide variety of other substances. Each of these analyses results in a number of data — and the ideal tool scientists need to sort, digest, record, and file this vast flow of figures in a sensible and easily retrievable way is the computer.

The central laboratory's computer system is based on a large Hewlett-Packard 3000 minicomputer, in use now for several years. It is the hub of the Laboratory Information System (LIS) and its 35 terminals are spread throughout the laboratory complex. As "languages", this system uses COBOL with a smattering of FORTRAN for programming.

The involvement of the LIS in the analytical process starts with the arrival of a sample at the laboratory. The sample may have been collected following a strictly prescribed procedure by a ministry field worker, a company monitoring itself, or a client doing research for the ministry, or at one of the regional offices.

Environment Ontario's regional offices in Kingston, Thunder Bay and London have their own laboratories for the processing of routine samples. For some analyses requiring specialized equipment and facilities, samples are forwarded to the central lab.

On arrival, the sample is assigned a number and a file is opened on it. It is also entered into the LIS system, where it is categorized as to what work is to be done and by which sections of the laboratory branch.

Serge Villard of Environment Ontario's Laboratory and Applied Research Branch at the keybord of his PET. (photo: John Korchok)

At each section, the laboratory technicians than perform the required tests and analyze and enter the data achieved into the LIS, which then generates appropriate reports. This system worked well until the LIS became overwhelmed by the increasing flow of data. Response time during busy periods often became much longer than could be expected from a computerized system.

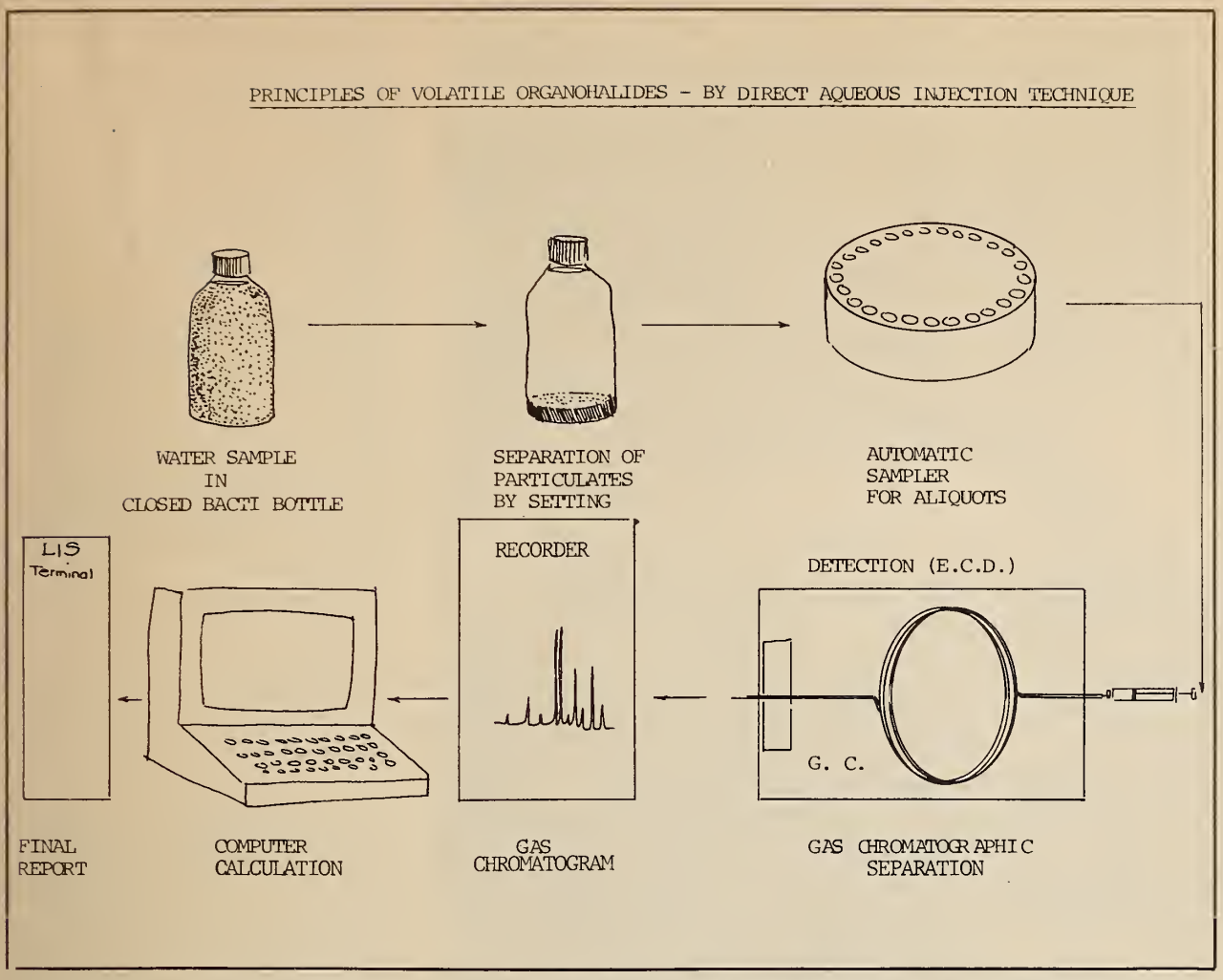
The control of the experiments and analyses, the evaluation of data and the entering of data into the LIS was being done manually.

Serge Villard, manager of the water quality section, pointed to laboratories where tests are still being done manually. At the ion chromatograph, for example, water samples are analyzed for fluorides, chorides, nitrates, and sulphates. The samples are taken from a carousel of test tubes and pumped into a filtering column which allows the lighter ions (fluorides) to move ahead of the heavier ones (sulphates).

The electrical conductance is read at the output-end of the column, where a peak reading is registered as each ion passes by. The height of the peak indicates the concentration, and the timing is characteristic of each ion type.

The output from the chromatograph is fed into a plotter and a technician measures the height and the timing of each peak on the resulting graph with a ruler. Thousands of readings on the graph must then be transferred and typed line by line into the LIS, a monotonous and exhausting task.

Another example is the work done on the inductively coupled plasma



The position of the PET and LIS computers in the sequence of the analysis of a water sample by direct aquaeous injection technique.

source emission spectrometer (ICP), explained Dave Boomer, emission spectrometer scientist. At the ICP, samples are injected into an argon plasma and the spectrum of the radiation emitted by the sample is measured. An analysis then reveals which elements the sample contains. The ICP does 25 tests per minute, and a full day's run of the ICP creates enough data to keep a technician calculating for three or four days.

Mr. Boomer, who is a chemist with an understanding of microcomputers, and some of his colleagues soon realized the saving in labor a suitable microcomputer could introduce into the system.

They decided to use a PET, one of the most popular microcomputer systems on the market.

The PET was assigned two functions.

The first was the control of experiments. The ion chromatograph is now controlled by a PET. Once the carousel is loaded with samples, the PET feeds them to the chromatograph for analysis. The results are fed through a custom A/D interface,

PET handles eight-bit groups

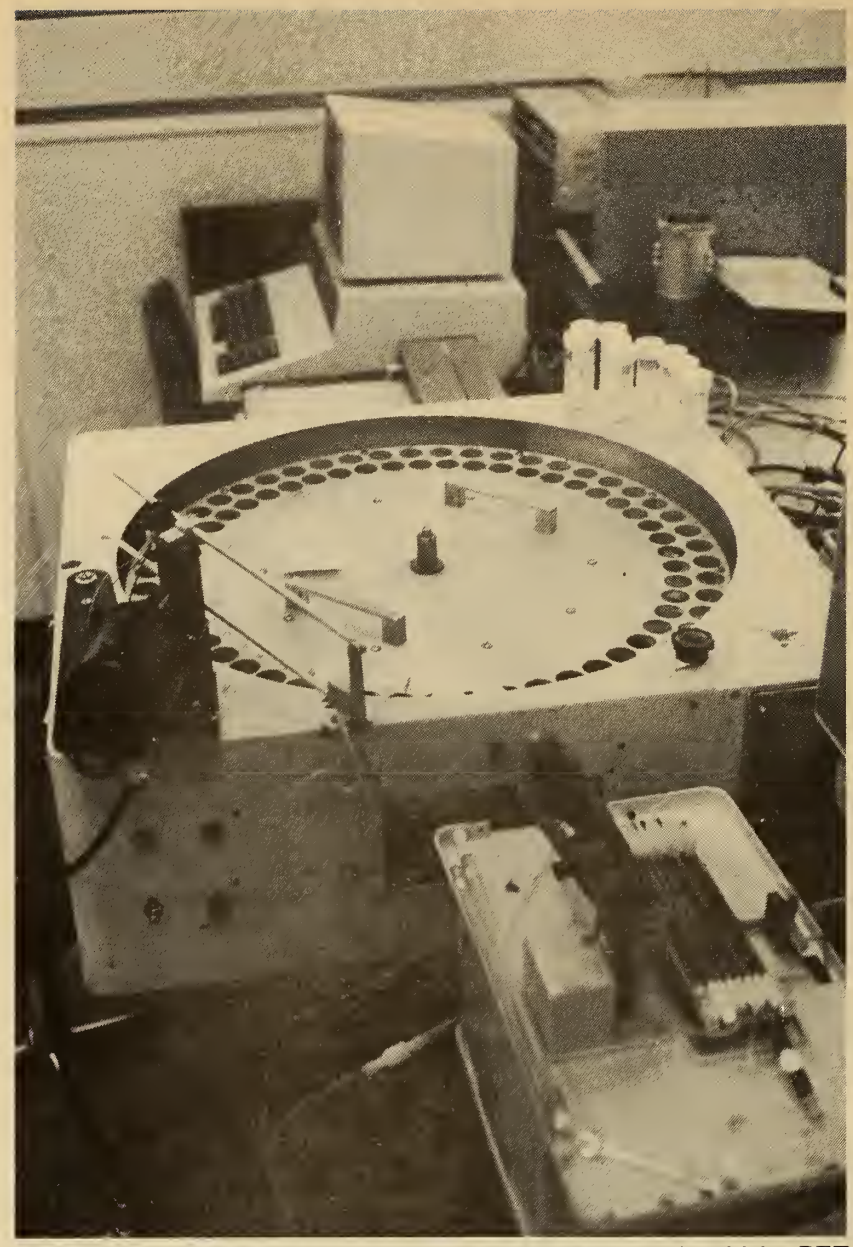
which converts the output of the chromatograph given in voltage variations to digits a computer can handle. The binary digits are then fed in eight-bit-groups to the PET.

The microcomputer measures the height and timing of the peaks and calculates the relative concentrations. It then stores the results in a memory disk. But that's not all. Every 45 minutes, the PET switches the chromatograph to a fresh column and regenerates the one just used.

At the end of a run, the PET shuts everything down, regenerates the columns again and readies the apparatus for a new run. If the carousel is loaded at 6 p.m., the PET can work through the night without supervision. The whole system needs attention only twice a day for two shifts of work.

Another example of this type of application is given by the wavelength dispersive X-ray spectrometer. Here a sample is struck with X-rays from precise angles and the resultant radiation is read.

The PET is used not only to move the X-ray gun from angle to angle by a stepped motor. It also checks the precision of the mechanism, calibrates



Part of an ion chromatograph system for sulphate analysis in which a PET (background) controls a sampler carrousel, a pump and the chromatograph. (photos: John Korchok)

the data and advances the results for more accurate measurements.

In its second role, the PET operates as data manager. Often the two roles of experiment control and of data management are intermingled — but in programming they have been kept as separate as possible.

In acid rain studies, for example, the acidity of water samples is measured by titration. Manual titration is a tedious process. Rumor has it that it has driven many a scientist mad. In the computerized system, the PET adds titrant solution to the sample and checks the pH through a custom-built BCD interface attached to an automatic burette and a meter. After each addition, the rate of change of the pH is calculated, and as the neutral point approaches, smaller amounts of titrant are added.

When the neutral point is reached, the amounts of titrant are increased again and the resulting pH-curves are used to calculate the acidity of the water by two different methods.

With the help of PET, the process takes between 5 and 20 minutes for each sample. Done manually, the job would take hours.

In the ICP example mentioned earlier, the PET performs the calculations almost as fast as data are registered and the technician on the job can keep the machine running every day instead of calculating for four days between runs. This adds up to a tremendous increase in productivity and efficiency.

In most cases, the immense volume of data collected is registered on a memory disk. The disk is also used to store the data. When reports are needed, a data base management program called The Manager is used to rapidly summarize, for example, sulphate concentrations in the rivers in the Sudbury region for November and December, 1982.

efficiency gets boost

The PET has helped to improve the efficiency of analyses, but its use can be taken much further. The nutrient analysis laboratory is a good example of such further use. The analyses done in this lab involve the automated mixing of samples with various reagents and the measuring of developed color by spectrophotometry.

For this application, a microcomputer system is being developed which uses PET and a Pulsar System 500 manufactured in British Columbia

The system will eventually control all phases of the experiment, managing the sample records, controlling the automatic analyzer, and capturing the results from the Pulsar System 500 processor.

The micros will also calibrate the system, do quality control samples, and analyze the data. This last is a tall order, since the data frequently include electrical noise, irregular peaks, peaks from air bubbles and all kinds of other disturbances a human can easily read, but which send the average computer into paroxysms of errors.

After the data are analyzed, a technician may check them, and then they

are transferred to summary disks. Late at night, the PET gives the LIS a nudge and requests data transfer service. The PET loads the day's data into the LIS through a Gandalf RS-232C interface. This not only makes better use of the expensive HP-3000 during off-hours, but eliminates the machine-human-machine problem in transferring data from the lab to the LIS. From the point of view of the HP-3000, which must spend countless nanoseconds waiting for slow humans, a PET is preferable by far.

automated units cost much more

Mr. Boomer was asked whether he would re-equip the lab the same way if he started today. He answered "Yes", and explained: "The available automated analysis units have two disadvantages; they're much more expensive and much less flexible than the PET system. Here, a $70,000 piece of lab equipment with $6,000 worth of computer and interface is performing the same function that a $160,000 integrated unit would perform. In addition, a PET can be reprogrammed more easily and can be connected with the LIS much more easily and cheaply."

As for PETs, their use is partly due to history and partly due to preference. When Mr. Boomer and Mr. Villard started working on automated analysis in 1978, the TRS-80, which they had also considered, didn't have a disk drive. The use of cassette storage made it impractical.

Mr. Boomer said that six months ago he was emphatically in favor of the PET, and today he would still choose the system. The lab has almost no use for the more powerful 16 bit microcomputer. Its needs are met adequately by the 8 bit PET system.

Computer programming has become a hobby for many. Programming enthusiasts meet in clubs casually named after the computer systems the members use. "If you go to a PET Club meeting," Mr. Boomer explains, "you meet everyone — from editors of computer magazines to 18-year-olds who stay up all night programming fantastic games. Many times, when we get stuck with a control problem, we run into a youngster at the club meeting who had just solved a very similar problem the week before."

Lab technician R.S. Hillier sets up the equipment for the analysis of metals collected by high volume air filters. All routine calculations in this system are performed by the PET, which also collects the data for later transfer to the LIS system.

A lab technician performs acid titration using a PET controlled system.

Mr. Boomer also feels that while the PET processor is not as powerful as others, it is easy to understand, and that gives it an advantage. This is also the reason why all programming on the PETs is done in the BASIC language.

The users at the ministry are scientists, not programmers, and they find BASIC programs easy to understand and easy to modify. Some older programs' listings end up as incomprehensible to anyone but the technician or scientist who wrote them.

The future of computers at the ministry is exciting. There will be more integration of microcomputers with the LIS minicomputers. The IEEE-488 buss will come into wider use, replacing the currently used RS-232C.

But the main task will be the development of a communications network among microcomputers. This will make real-time quality control possible.

Results will be traced as they're being produced. This will mean greater accuracy and reliability of tests. Networking will also enable staff to recall more information in less time. And it will increase the accuracy and reliability of scientific work and, as a result, promise a better life for all of us.

$3 million to measure, identify, monitor, warn

In 1983-84, Environment Ontario will spend more than $3 million on water quality studies on the Great Lakes and connecting waterways.

The Great Lakes surveillance program reflects the priorities and needs of the ministry to investigate areas of water quality degradation, measure effectiveness of remedial programs and actions, provide early warning of emerging problems and identify long-term trends.

Studies planned, under way or nearing completion are:

Lake Ontario

Niagara River

This year's $205,000 includes assessments of the impact of U.S. and Canadian industrial and municipal discharges and drainage from tributary streams. Emphasis is placed on detecting traces of contaminants and their effect on water quality and biota.

Toronto Waterfront

A total of $260,000 is being spent to monitor water quality along the Toronto waterfront. Assessment of potential interference with water uses such as water quality, is monitored for effects of dredging and lakefilling construction. In co-operation with the City of Toronto Public Works Department and the City Health Department, bacterial water quality is monitored.

Humber Bay

About $100,000 has been designated for assessing the impact of the Humber sewage treatment plant on nearshore water quality. The effects of the Humber on nearshore water quality are also being investigated to support the Toronto Area Watershead Management Strategy program.

Other projects:

Some of the continuing work on Great Lakes water quality involves:

- Reporting on the investigation of the effects of Hamilton Harbor on Lake Ontario nearshore and the effects of the reduction of ammonia, biological oxygen demand (BOD), and phosphorus inputs on water quality in Hamilton Harbor.
- Assessment of the effectiveness of a modified outfall diffuser at the Lakeview Sewage Treatment Plant.
- Monitoring of inorganic chemicals accumulation in Cladophora algae at selected sites in the nearshore as a basis for monitoring future changes in lake water chemistry.
- Bacterial water quality investigation near Port Weller and Port Dalhousie.

The 60 ft. Guardian One is the flagship o

ronment Ontario's fleet of five vessels engaged in surveillance work on the Great Lakes. (photo: Hans Eijsenck)

Lake Superior

To update findings of the 1973-76 Lake Superior studies, Environment Ontario's Water Resources Branch is conducting intensive water quality studies in Lake Superior. These surveys also constitute the ministry's contribution to the 1983 international intensive study on Lake Superior co-ordinated through the International Joint Commission.

Nine Lake Superior Bays

An allocation of $127,000 has been provided to examine nutrient and contaminant levels immediately after the spring melt in nine bays to compare current water quality information to that collected in 1973.

Thunder Bay, Nipigon Bay, and the Peninsula Harbour

These three areas have received funding of up to $351,000 among them to determine the condition of the aquatic environment in their areas. Much of the impact on these environments has resulted from historic waste-water discharges from pulp and paper mills. Jackfish Bay was also investigated in 1981.

An assessment of sediment composition and chemicals absorbed by bottom-dwelling organisms in these three Lake Superior bays and three other bays without industrial discharges will absorb $157,000 of the budget.

Lake St. Clair, Lake Erie

For the documentation of levels of contaminants in sediments and simple bottom-dwelling organisms in Lake St. Clair, $70,000 has been allotted. These activities were co-ordinated with those of the University of Windsor, Great Lakes Institute. Sediment cores will also provide a look at the historic accumulation of contaminants in the lake.

St. Clair River

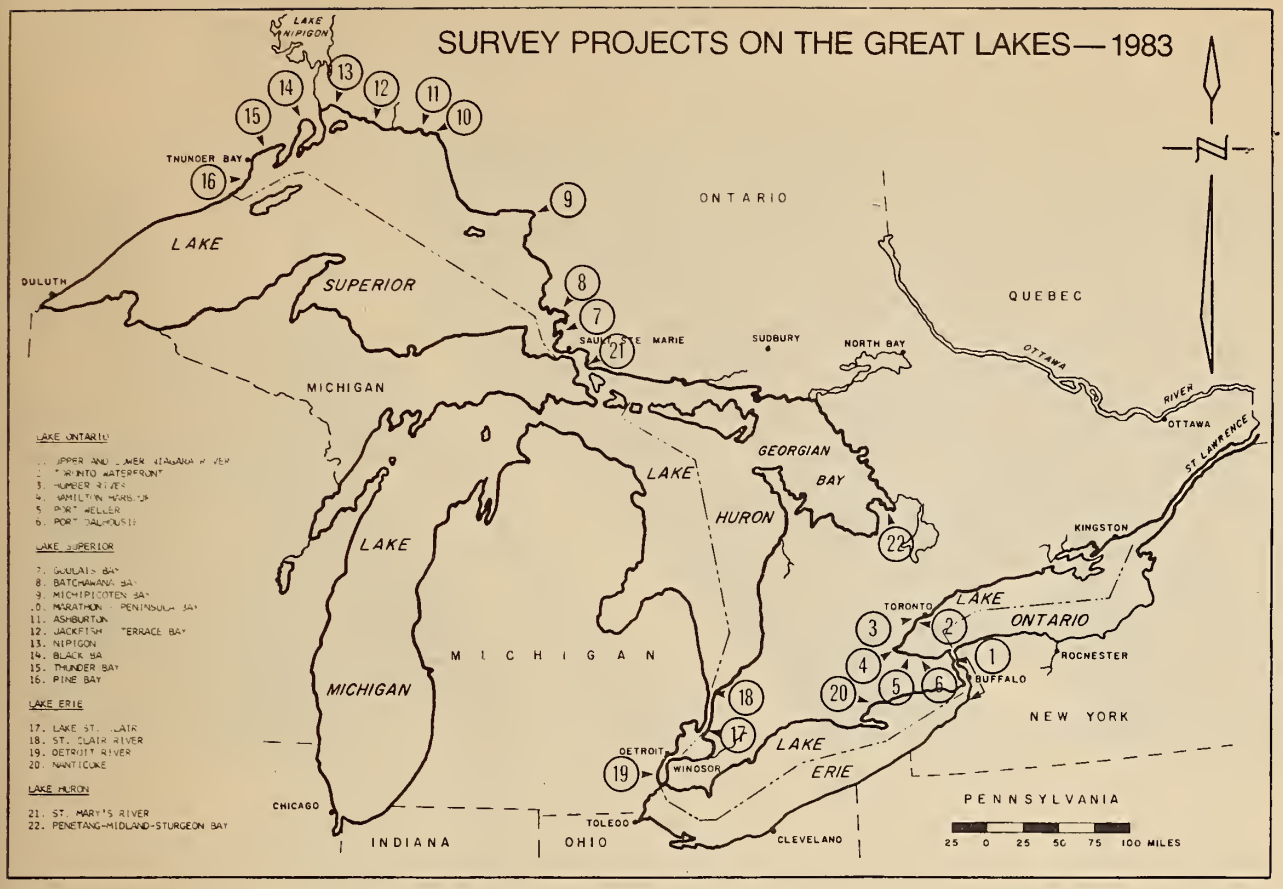
An estimated $60,000 was used to evaluate the effectiveness of new pollution control measures by industries and the study of conditions of sediments in the St. Clair River. Studies at Sarnia Bay will provide information for design of corrective actions for storm and sanitary bypass sewers.

Other projects:

The effects of discharges to the St. Clair and Detroit Rivers, using freshwater clams and young-of-the-year fish as indicators of pollution sources, are assessed continuously.

The study of the impact of increased municipal and industrial development at Nanticoke in Lake Erie was continued.

Monitor I, one of Environment Ontario's smaller surveillance vessels, is being loaded with sampling equipment at the dock in Thunder Bay for a surveillance project on Lake Superior. (photo: Tessa Buchan)



St. Marys River, Lake Huron

St. Marys River

A total of $120,000 has been assigned to evaluate the effects of St. Marys River flow changes after the completion of the Great Lakes power hydroelectric project. Knowledge of sediment quality and bottom organisms is also being updated.

Penetang-Midland-Sturgeon Bay

Assessment of improvements of water quality resulting from the provision of larger treatment facilities and phosphorus removal at sewage treatment plants in this area accounts for some $42,000 of the yearly budget allotted to Lake Huron.

Great Lake water quality surveillance work is sometimes a very wet job. (photo: Tessa Buchan)

A diver retrieves a container of clams that had been placed on the bottom of Lake Ontario to determine the presence of contaminants. (photo: Tracy White)

Other projects

Waterworks Intake Monitoring

Approximately $145,000 has been allotted for weekly monitoring of lake water quality at the intakes of 17 water treatment plants. The main objective of this project is monitoring long-term trends in water quality in nearshore areas.

Tributary Monitoring

A total of $123,000 has been budgeted for the continued monitoring of nutrients and contaminant levels in 17 major tributaries to the Great Lakes.

Information on tributary loadings to the lakes is essential for mass balance calculations as well as to provide input for assessing the effectiveness of the phosphorus control program.

Data Management

The maintenance, quality control updating, and operation of a computerized Sample Information System to streamline the flow of field and laboratory data requires $160,000 for its annual operation.

Other projects:

Surveillance continued of young fish (spottail shiners) contaminants, especially in the Niagara and Detroit Rivers. Since 1975, data have been collected from 81 sites.

The potential environmental impact of contaminated lake bottom sediments, and the development of management strategies to protect the aquatic environment is continuously being assessed.

Radioactivity is monitored at uranium mining and refining locations and at nuclear generating stations.

Development of cost-effective and reliable instrumentation for sampling continues.

Scientific and technical support is provided for the International Joint Commission and the Canada-Ontario Agreement Review Board to fulfill Environment Ontario's commitment to the Great Lakes Water Quality Agreements.

●

There isn't a jurisdiction anywhere as rich as Ontario in the world's most valuable resource, fresh water.

During the past 30 years, Ontario has done more than most of its North American countertparts to protect this unique wealth. It has spent close to $5 billion to provide sewage and water treatment to more than 90 per cent of its population. Its phosphorus control and the control of industrial emissions into the Great Lakes are among the most advanced in North America.

A good analysis depends on good sampling

By Tracy Peverett

A $10 water sample taken improperly may destroy the validity of a $1,000 analysis. Often much more than dollars are at stake. A badly collected series of samples may conceal a situation that may be harmful to people and the environment, says Ron Hunsinger of the water technology section of Environment Ontario.

There was a time when sampling was considered to be the easiest step in arriving at an analysis. But as we deal more and more with testing for minute amounts of pollutants, methods of sampling have become very important.

At first glance, water sampling appears straightforward; a simple task of pouring water into a bottle. But there is much more to it than that, Mr. Hunsinger says. Many important variables must be considered to ensure accurate results.

Before sampling can begin, the container has to be approved for the type of sampling planned. The size is important, as is the type used, be it plastic or glass. In asbestos testing, for example, Mr. Hunsinger explains, two types of polyethylene containers are available, but only one can be used. Use of the wrong kind will result in an inaccurate analysis.

The choice of container is only the beginning. The size of the sample is also important, and whether the bottle should be filled to the brim or left with a headspace.

The site of sampling is also crucial: Should the sample be a grab or a composite, from the plant, or at the source? Once the sample site is chosen, steps have to be taken to ensure that materials in samplers, work areas, sample pumps and piping and in the distribution system will not contaminate the sampling.

That is the "how to" of sampling. The next step involves the "what", the parameters of concern. While analyzing sample water for specific compounds it helps to have something to compare the results with. An analyst should test established parameters such as pH levels, etc. in order to relate his new data to existing information.

Sampling should be carried out, if possible, at standardized set locations, and process steps should be normalized so that variables will not be affected by changes in location.

"You have to establish beyond any doubt that you are getting the sample that you set out to obtain," says Mr. Hunsinger.

It is important to consider when samples should be taken. If you want to make sure you are testing and comparing the same water coming out of the plant as the water you've tested on its way in, the plant retention time must be taken into account. In a water treatment plant, for example, the retention time can vary from a few minutes to a few days depending on plant size and capacity.

Once the sample has been taken and is ready to go to the laboratory, shipping time has to be considered. In asbestos sampling, for example, 48 hours is a critical time. A sample kept longer before analysis is irreparably altered. Some samples have to be frozen, while others will be ruined if refrigerated, so the question of storage also becomes crucial to the value of the sample.

Quality control in the laboratory is important, but the laboratory must make sure that the samples it receives are worth testing.

poor sampling — poor data —

"If a bottle arrives at the lab with headspace, and the sample was supposed to fill the bottle, it should not be analyzed," says Ron Hunsinger. "This is especially important in matters of health, where an accurate sample is absolutely crucial."

Inaccurate samples can create unnecessary public concern. When samples were taken to detect asbestos in the early 1970s, Mr. Hunsinger says, sampling and analysis revealed high levels of asbestos in many test areas. In the mid-1970s, when standardized methods of analysis were set up, it was discovered that many of these locations did not contain any traces of asbestos.

"In areas of public concern, this may cause difficulties. Sometimes we must face that we do not have the valid methods and then the public will have to wait until they are developed. Waiting for proper methods of sampling and testing is preferable to carrying out hasty and possibly inaccurate tests."

The Environment Ministry is currently revising sampling protocols to eliminate problems of variables in sampling for drinking water. This program will standardize the methods used to take water samples throughout the ministry.

A standardized method will provide data for public information on drinking water quality as well as supply much-needed background for research into drinking water improvement. Such a standardized method will also allow data comparison between different laboratories.

"It's time that we really turned our eyes beyond the laboratory door," Mr. Hunsinger says.

Chemists should become more involved in the variables of a sample and where it comes from, he says. While he admits it is not easy to get scientists into the field, he feels they should have a more active role in designing programs for sampling and training field people.

"The most important thing to remember," says Mr. Hunsinger, "is that the final data are only as good as the sampling procedure used."

Diversions may threaten 37 million people

By W.A. Steggles

Canadian federal and provincial governments have become concerned about the apparent lack of support in the United States for Great Lakes programs. They remain uncertain about the full impact of proposed cutbacks in programs in the U.S. affecting unfinished construction of sewage works, surveillance, monitoring and technical support for programs to control toxic substances.

Further, in June, 1982 the premiers of Ontario and Quebec, the two provinces bordering the Great Lakes-St. lawrence River system, in recognizing the threats to the system from proposed divisions of water to the southern states, supported the action taken by the governors of the eight Great Lakes states in opposing further diversions and calling for further monitoring of the situation by the International Joint Commission.

The concerns about water quality were taken up by the IJC in its First Biennial Report under the 1978 Great Lakes Water Quality Agreement and were also outlined by the U.S. Comptroller General who reported to Congress earlier in 1982 that the United States would not meet its objectives under the International Great Lakes Agreement.

The Comptroller General urged the Congress of the United States to take steps to improve U.S. efforts to clean up the lakes which have been hampered by 1) lack of effective overall strategies, 2) lack of knowledge about the extent of pollution problems and the impact of controls, and 3) the need for improved management of Great Lakes clean-up activities.

Recently, the U.S. Environmental Protection Agency has signalled this situation may change.

Demands on Great Lakes Resources

Regarded as the central Great Lakes issue commanding most public attention, water quality is usually considered to affect people long after any possible short-term gain that might result from the withdrawal and sale of water from the lakes. Nevertheless, in addition to pressing water quality issues, we now must recognize that the threat to the Great Lakes has taken on a new dimension — the calls for diversion — raising the stakes even higher and requiring careful consideration of both quality and quantity issues together.

As the interest in replenishing local water supplies seriously depleted in parts of the thirsty southern states grew, it became abundantly clear that localities seeking additional quantities of supply were pursuing this end without paying sufficient attention to the need to manage their local supplies and associated pollution problems.

Indeed, the latest proposals to divert more water from the lakes would be accompanied by returning flows of lesser quality water to the lakes. Coupled with increasing evidence of serious pollution of ground water in certain sections of the drainage basin, these proposals telegraphed the message that the Great Lakes environment, together with the economic wellbeing of many millions of persons in Canada and the United States, could be under further grave threat.

When seeking additional supplies from large-scale diversions at subsidized cost, continued consideration of water as a cheap commodity discourages conservation which could be expected to reduce demand and either forego or eliminate the need to import water across drainage divides.

Frequently forgotten in these exchanges between the south and north on the subject of interbasin transfer of water is the Boundary Waters Treaty between Canada and the United States which does not allow either country to divert water into or out of the lakes in a way that affects natural levels and flows, without the approval of the International Joint Commission — unless, the two governments approve the diversion without reference to the commission.

From a Canadian perspective, such an eventuality is considered to be highly unlikely as opposition from navigation, power and shore property interests would, at the very least, be strongly asserted.

By way of background, water levels and flows in the Great Lakes system are directly influenced by man-made diversions, control structures and channel changes operating within the variations of the natural supply of water to the lakes. Changes in levels and flows have both enironmental and economic effects which may be opposing one another.

For instance, diversions into the lakes as well as high levels favor the generation of hydroelectric power. High levels also favor shipping and boating as draft in shallow areas is improved. On the other hand, low lake levels reduce erosion of shorelines and increase the area of exposed beaches to the benefit of shore property interests.

From an ecological point of view, rapidly changing levels are probably more harmful than extremes of either low or high levels.

There is a variety of man-made diversions of water out of the system. They include the Erie Canal (insignificant flow); the Lake Michigan diversion — 3200 cubic feet per second (cfs), annual average, and the Welland Ship Canal — 7500 cfs. Two diversions of water into the system bring Arctic waters into Lake Superior through the Long Lac and Ogoki diversions (5600 cfs).

Ontario, Michigan combine forces

Ontario Environment Minister Andrew S. Brandt and Ronald Skoog, head of the State of Michigan's Department of Natural Resources, have agreed to enter into negotiations to update the Memorandum of Understanding which Michigan and Ontario signed in 1974.

"The old agreement has served our province and the State of Michigan well," Mr. Brandt said. "As a result of joint monitoring and abatement activities, there has been a dramatic improvement in air quality in the Detroit/Windsor, Sarnia/Port Huron corridor. Besides carrying on existing co-operation, the new agreement would address new issues of concern, and we both feel that the excellent co-operation achieved in the past will be a solid foundation to build on."

Ontario and Michigan intend to consult their respective federal governments once the new agreement has been drafted. Co-operation between the state and province will continue, and may or may not be carried out under the umbrella of the International Joint Commission, depending on the outcome of further discussions with the federal government.

Environment Ontario employees collect $28,000 for United Way

As in previous years, Environment Ontario's employees working in Metro Toronto exceeded the goal set for them in the 1983 United Way campaign and contributed a total of $27,963.

Under the chairmanship of Stephanie McDowall, 830 employees contributed a total of $26,178 in cash and payroll deductions. An additional amount of $1,785 was raised by special events as bake sales and bazaars.

Although the overall participation rate of 67.6 per cent was somewhat lower that in 1982, several ministry branches achieved a much higher participation rate - among them the Waste Management Branch (100 per cent participation), the Environmental Assessment Board (100 per cent), the Air Resources Branch (90 per cent), the Laboratory Services Branch (86 per cent) and the Main Office (85 per cent).

Consumptive Use

A major diversion of water from the Geat Lakes results from the consumptive use of water; that is, water withdrawn and evaporated or transported away in industrial or commerical products. The net consumptive use in 1975 was 4900 cfs, projected to increase up to 37,000 cfs by the year 2035, principally because of expected increases in thermal power plant cooling needs.

Water Quality Maintenance

Diversion of water out of the Great Lakes system reduces water available for water quality maintenance, a factor which may become more significant if persistent substances which accumulate in the lakes are not adequately controlled.

Also, frequently overlooked in discussions about diversions and consumptive use is the effective diversion which occurs when water is polluted — as vast quantities of water may become spoiled for use or fail to support some of the life in the ecosystem.

And, when toxic chemicals, even in trace amounts, damage or cripple parts of the life systems dependent upon these vast resources — the home for countless creatures, including 37 million Canadians and Americans — concerned citizens become determined to press the attack on such abuses as well as diversions that seemingly could deplete the Great Lakes.

It was in a spirit of mutual concern and regard for past joint accomplishments that the eight Great Lakes states realized last year they should band together with their Canadian neighbors in Ontario and Quebec to further protect these priceless and possibly their most endangered natural assets.

Accordingly, the governors of the eight states and premiers of the two Canadian provinces resolved to oppose any water diversion to water-poor regions of the United States as they recognized that lowering water levels would cause serious losses in water supply, the result of which would be increased shipping costs, decreased hydroelectric generating capacity and serious economic, social and environmental problems for the people of the Great Lakes area.

The leaders of the Great Lakes states also chose to focus on the need to improve management of U.S. Great Lakes programs, and to increase research into water pollution. The governors and premiers also resolved to urge their respective national governments to seek better coordination of efforts in setting standards for toxic substances in the lakes.

Two-pronged effort to expand knowledge

By Gerard C. Ronan

There are approximately 60 thousand chemicals in general use. About 5 million organic compounds are registered in Chemical Abstracts. Each year sees approximately 1,000 new or modified formulations appear on the market.

There is insufficient information available to predict the long-term biological impact of these materials either singly or collectively upon man and his environment. There are insufficient laboratory facilities available in the world to carry out the required animal studies, and the financial resources required to complete such studies are astronomical.

There is a growing scientific data base on the genetic toxicity of some of these chemicals. Recently damage to genetic material has become an important concern and therefore the need to screen this vast number of chemicals has become a prime objective of many jurisdictions. In answer to this need, Environment Ontario is conducting a two-pronged effort to expand our knowledge of mutagens and provide a sound base for standard-setting and regulatory decisions.

Mutagenic Agents

A mutagenic agent is defined as a substance that can alter the genetic makeup of a cell. A mutagenic agent acts at the individual cell level; it can induce genetic damage in somatic cells or in reproductive cells.

The damage in somatic cells can lead to cellular diseases like cancers; the damage in reproductive cells can lead to birth defects. A common feature of all these diseases is the initial occurrence of a mutagenic event. The human embryo in its formative, early cell stages is most vulnerable to the action of those chemicals capable of triggering a mutagenic response.

Mutagenicity Testing Objectives

Mutagenicity testing has two objectives: to isolate and identify mutagenic compounds, and to measure the potency of the mutagenic hazard. Currently there are three major methodologies to identify mutagenic or genotoxic agents. These are epidemiology, long-term animal studies and genotoxic tests. The associated costs and time frames for these methods are significantly different.

Methodologies for Identifying Genotoxic Agents

Epidemiology, which involves the study of diseases in human populations, provides the most reliable data on human health effects of environmental contaminants. Unfortunately, the costs are prohibitive, ranging upwards from $500,000 per study. The studies can span 10 to 15 years before an effect can be identified in a large population. Since it is extremely difficult to isolate mutagenic effects in large populations, epidemiological studies usually focus on isolating the chemical cause of specific diseases, or on determining the effect on a population exposed to specific chemicals.

Long-term animal studies are used to determine if there is a relationship between a chemical and a specific disease. Animals undergo acute or chronic exposure over their lifetime to a suspected agent. Autopsies then determine the cause of death and the presence of any disease. Such tests are costly and time-consuming, requiring two to five years. The world's testing capacity is limited to 100 to 200 chemicals per year. They have the advantage that they establish the cause and effect or agent/disease association.

The third type of testing is the short-term genotoxicity tests. These tests can be carried out relatively quickly (four to 12 weeks) and the costs range from $1,000 to $3,000 per test. They provide a rapid means of screening out those agents possessing mutagenic properties. These tests are effective analytical tools to identify potential genotoxic hazards and to evaluate their action on biological systems. A major advantage of short-term tests is their applicability to a wide variety of sample types. They have been used on the following type of samples:

1. Pure chemicals
2. Industrial effluents and emissions
3. Waters-surface/ground/drinking
4. Landfill leachates

A close-knit development approach involving our expertise in biological testing and chemical techniques is needed to expand their use on environmental samples.

To generate a sound, well-validated data base for environmental matrices, the following analytical functions need to be addressed:

1. Develop mutagenicity tests
2. Develop concentration systems
3. Assess performance of test systems
4. Test environmental samples
5. Interpret test results.

Biohazard Lab

The Ministry of the Environment Biohazards Lab has brought on-line five test systems to conform to the test battery approach for validating data:

the Salmonella point mutation assays (Ames test),
the E. coli DNA repair assay (Rosenkranz test),

the Chinese Hamster Ovary Sister Chromatid Exchange assay, the mouse abnormal spermhead morphology assay.

Most short-term tests follow the same basic process. The sample extract is applied at varying concentrations to the test system or organism. The substance under test is tested directly or metabolically activated by the addition of a special enzyme. After the elapse of a defined amount of time, the system is examined for signs of genotoxicity. The following brief description of the Ames test may illustrate the relative simplicity of these test systems.

Ames Test

The Ames test, developed by Dr. Bruce Ames in the late Sixties, is the best-known and most widely used of short-term tests. It is relatively rapid and inexpensive. As an extensive data base on the assay exists, good correlation has been achieved between known cancer-causing agents and the frequency by which they are detected as mutagens.

The Ames test operates on the following principle: A special line of Salmonella bacteria have been engineered so that they now lack the ability to make histidine, and amino acid essential for growth. The mutated Salmonella cells are placed in a medium which contains the sample being tested. If the sample is non-mutagenic, nothing will happen and the cells will not grow. If the sample has mutagenic properties, it will re-mutate the cells and enable them to manufacture histidine, which in turn triggers cell growth. The proliferation of colonies on cell growth plates indicates the presence of a mutagen.

(photo: Dr. Michael Salamone)

The effect of mutagens or chromosomes is made visible by a special staining technique used at the ministry central laboratory. The (circled) non-affected chromosome shows evenly distributed lighter and darker staining of its chromatid arms. Interrupted or broken staining, visible under a microscope on several chromosomes in the photo, indicates sister chromatid exchanges, sure indicators of mutagen action.

Sample Concentration and Extraction

To properly carry out mutagenicity testing, strong front-end chemistry support must be available. Great care must be exercised in deciding upon sample concentration techniques and the methods employed to extract the various sample aliquots. For example, changing the solvents used in extracting samples can result in false positives. Insufficient care in extracting and separating the various sample fractions can result in subsequent toxic shock to the bacteria, resulting in anomalous data. Consequently it is essential to have a well-defined proven sample concentration and chemical extraction procedure in place before undertaking short-term tests.

Data Confirmation

Positive Ames tests indicate a potential genotoxic hazard. To corroborate the Ames test result, a "core battery" of short-term tests should ideally be performed. The minimum number of tests suggested ranges from three to five. There are currently over 40 short-term tests to choose from. The battery of tests normally have different mutagenic end points which signify a mutagenic event has occurred. They vary in the type of organism impacted upon, for example, yeast cells or mammalian cells.

The degree of agreement between the various mutagenicity results obtained with different test systems is considered the best measurement of a test's accuracy. In attempts to extrapolate the findings to determine the hazard to man, greater confidence can be placed on data validated by several test systems.

The short-term tests can give false positive or false negative results. Normally these errors will be caught during follow-up repeat testing or by non-confirmation with other test systems.

Data Acceptability

In the Ames test, three criteria are applied to data sets to ensure the integrity of the results. The first is a demonstrated dose-response relationship, in which increasing concentrations of the unknown compound show a proportional increase in mutations of bacterial cells.

The second criterion requires that the number of cells which grow on the plate be approximately twice the background level. The third criterion is that the test result can be reproduced when the sample is retested.

Relative Risk Index

Long-term animal studies and epidemiological data are the best sources of information on the genotoxic effects of a chemical. However, because of the limitations of these tests, there are relatively few supporting data available from these sources. Short-term mutagenicity tests are but the first phase of a test system designed to assess if a substance poses a genotoxic hazard to man. They are the most cost-effective means of obtaining information on a large number of sample sources.

In the interim, short-term mutagenicity testing will be used primarily as an indicator test system in environmental monitoring programs. In dealing with complex environmental samples, the test can be used to warn of the presence of a potential hazard, and to indicate what specific fraction of the complex mixture contains mutagens.

Hazard Assessment/ Standard Setting

There is an alternative and more practical approach towards incorporating mutagenicity findings in regulatory requirements. Guidelines could be developed based on observed genetic damage to resident environmental species. The guidelines can use data from short-term tests applied to plants, animals or fish exposed to environmental levels of the suspected hazardous agents. Detection of measurable damage in such in situ systems would indicate the presence of a genotoxic hazard. A number of studies carried out shows that this is a workable method for gauging the impact of environmental genotoxic hazards on selected target species.

Research and Development

The ministry is conducting a two-pronged effort to expand the information base upon which rational standard-setting and regulatory decisions can be made.

The in-house efforts have been directed to the provision of a lab facility that meets the safety requirements for handling mutagenic chemicals. A newly-constructed biohazards lab costing $450,000 was brought on-line. This facility is designed to isolate, contain and remove any mutagenic material from the lab's air or wastes, to provide a safe work place for all laboratory staff, and to prevent the discharge of hazardous materials to the atmosphere. Scientists are using a number of short-term tests for specific environmental studies, and are simultaneously carrying out development work on new tests and the refinement of existing tests. The intention is to develop and maintain on-line a well proven battery of short-term tests to support the ministry monitoring programs.

The other thrust of the ministry program is to fund research in universities with a demonstrated capability in this area. To date over $580,000 has been allocated to this research area.

The projects under way are:

1. **Enviromental Mutagens, Promoters and Inhibitors**
   The key elements of this York University study are the effects of promoters and inhibitors on the action of mutagens and the response of mutagenic substances in combination.
2. **World Health Organization Interlaboratory Comparison**
   This study, conducted by MOE and York University scientists, is to evaluate the short-term tests mentioned here in order to have validation and international approval and acceptance of these tests.
3. **Fish Mutagenicity Assay**
   This University of Guelph study is developing and evaluating a fish assay, specifically the fish embryo, as an in situ system for the detection of genotoxic activity in the field.

Geoff Jenkins, scientist at the biohazard and virology section of Environment Ontario's central laboratory, is preparing a tissue culture for a mutagenicity assay. (photo: Tessa Buchan)

4. **Mouse in Situ Study**
   The study, at the University of Windsor, is to evaluate the Sister Chromatid Exchange assay on mice as an in situ test for monitoring environmental mutagens in the atmosphere.

5. **Literature Retrieval Methods**
   A computerized literature search under way at York University to establish a library of references on mutagenic compounds in the environment.

Environment Ontario is developing a strong internal and external scientific capability allied to an extensive data base. This will augur well for any future decisions which have to be made, to detect and measure genotoxic hazards and to assess their impact upon the environment.

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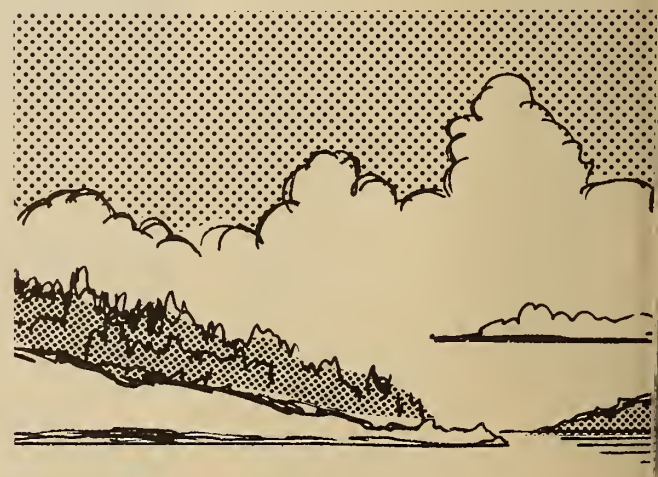
Helle Tosine. Dioxin News is prepared, collated and distributed to about 200 scientists world-wide as a forum for dioxin/furan research.



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Copies of the above publications are available from the approporiate section, or at the libraries of Environment Ontario at 135 St. Clair W., Toronto, or at the Main Laboratory on Resources Rd., Islington.

Arsenic control plant on stream

By Tracy Peverett

Environment Ontario's $1.1 million Deloro arsenic removal project was unveiled on July 11 at an Open House designed to demonstrate its effectiveness to area residents. The public was welcomed by ministry staff, who conducted tours of the site and provided information about its operation.

Since early 1979, Environment Ontario has been both testing and treating arsenic contaminants in the Moira River Basin. The arsenic is a residue left over from gold and silver mining and smelting operations. It was buried when the company closed in 1961 and has since reached the groundwater table and is leaching into the river.

Arsenic is a non-metallic, poisonous element which is found in a wide variety of natural organic and inorganic materials. While traces of the element can be found in most living organisms, and it is commonly absorbed into the body through ingestion or respiration, too high a level can result in arsenic poisoning.

Arsenic in water supplies is a potential environmental and health hazard, and in the Moira River Basin, treatment facilities were upgraded to treat arsenic contamination.

"The ministry's aim is to decrease arsenic levels in the area to a yearly average of 0.05 parts per million (ppm) with a maximum at any given time of .2 ppm," said Ralph Moore, former regional director of the ministry's Southeastern Region. "These standards will provide a margin of safety to consumers of drinking water."

The Deloro arsenic treatment facilities, completed in January of last year, consist of an 80-metre-long concrete dyke along the river, an 11,300 cubic metre equalization pond, a collection system including five pumping stations, and an arsenic treatment plant.

Groundwater containing 10 — 30,000 ppm arsenic and some surface water is collected by the concrete dyke and collection piping and pumped to the clay-lined equalization pond. The water is then pumped from the lagoon to the arsenic treatment plant.

At the plant, the water undergoes treatment with ferric chloride, lime and polymer. Large ferric arsenate particles are formed and settle out in the clarifier. From here they are pumped to holding tanks in the form of a brownish ferric arsenate sludge.

The clear water effluent, with 99.5 per cent arsenic removal, is discharged into the Moira River.

In July of 1982 construction began on the new collection, storage and treatment system. Construction involved renovating the existing lab buildings, supplying and installing the new dyke, building the new equalization pond and installing a collection tile system in the pumping station.

To date, the ministry has spent approximately $2.5 million, including the cost of the new plant, to clean up the site, and treat arsenic contamination in the area.

Laboratory branch restructured

The main functions of Environment Ontario's laboratory branch, to provide analytical services and to provide applied research, are reflected in the recent restructuring of the branch.

The applied research group is now composed of three sections.

1. Environmental Technology Section is formed by the consolidation of the Applied Sciences, Water Technology and Wastewater Treatment sections, and has Dr. Ken Roberts as manager.

2. Biological Sciences Section comprising Microbiology, Quality Control, Mutagenicity and Virology, is under the management of Larry Vlassoff.

3. Aquatic and Terrestrial Ecosystems Section consists of some of the research-oriented functions (Toxicity, Taxonomy and Limnology) previously carried out in Water Resources Branch. Jane Pagel is the newly appointed manager of this section.

Besides the three sections, engineering guidance and direction is provided to various ministry groups by Mel Fielding, engineering specialist, in the Applied Research group.

Jim Bishop is the assistant director of the Applied Research Group.

Serge Villard has assumed the dual function of assistant director for the laboratory services group while remaining as manager of the Water Quality Section.

Dr Barry Loescher has been appointed manager of the Inorganic Trace Contaminants Section to fill the vacancy created by Mr. Bishop's move to Research. The internal workings of the Water Quality and Trace Inorganic Sections are otherwise relatively unchanged.

The organic analysis function has been more fundamentally altered. Pesticides and Organic Trace Contaminants have been restructured into three sections:

1. Organic Characterization, headed by Dr. Otto Meresz, will deal primarily with special and non routine identifications and complaints.

2. Gerry Rees will manage the Trace Organics Section which will handle organics and pesticides analysis of air, biota, hazardous wastes and landfills.

3. Helle Tosine has been promoted to manager of the newly created Drinking Water Section, which is responsible for dioxin/furan testing, priority pollutants and other routine organic water scans.

It's all one world...

First deposit-return automat

Up to now automated vending machines swallowed your money and gave you something in return (if all went well). Ontario's first mechanized bottle return machine does the exact opposite: it swallows your (empty) bottles, decides whether they are returnable or not, sorts them, adds them up and prints a receipt for which you get money at the nearest check-out counter at the Food City supermarket in the Oakville Place shopping centre.

The manufacturers of the machine claim that it does the work in about half the time it takes to sort and classify the same bottles by hand. On top of it all the reversed vending machine delivers bottles and crates by conveyor belt directly to a storage area for pick-up and return to a useful service.

(photo: Tessa Buchan)

Taxes to fight global warming

The controversy about the global greenhouse effect continues unabated. A recently released report of the U.S. Environmental Protection Agency warns that the continuing release of CO_2 to the atmosphere may have serious effects on the global climate during the next 10 years.

In contrast, the U.S. National Research Council (NRC) concluded in a study published a few weeks later that the greenhouse issue "may be reason for concern, but not for panic."

The study, prepared in cooperation with the Scripps Institution of Oceanography, said that the "prospects are much less alarming than some earlier calculations made them appear."

Both reports agree that the levels of CO_2 in the atmosphere will about double from the 1860 level of 270 parts per million to about 600 ppm in 2060, and that this would increase the average temperature by 2° C.

To control such an increase, the EPA suggests a 100 to 300 per cent tax on the use of fossil fuels throughout the world. The reduction in fuel consumption brought about by such taxes may achieve a lowering of the average temperature by 1.3° C by the year 2100.

Considering such a tax, the NRC finds that it is likely that poor countries would refuse to join the rest of the world in paying higher fuel prices just to supress CO_2 emissions.

The NRC report asks for more research and concludes that it is probably wiser not to act aggressively right now when the future consequences of CO_2 increase are really not known.

Dr. George Keyworth, U.S. President Ronald Reagan's science advisor, disowned the EPA study. He said that there is, at this time, not enough evidence to indicate that a gradual rise in CO_2 in the air would have sufficiently pronounced environmental effects to require immediate corrective action.

Unsolved mysteries of composting

Since chemists about 300 years ago found better ways to make gunpowder than by producing saltpeter from compost heaps, not much has changed in composting, nor has research succeeded in answering the many basic questions about how composting affects the growth of plants, writes Chris Catton in New Scientist.

The few researchers who have tried to investigate compost have run into a maze of problems. They have found, for example, over 300 species of fungi in a single batch of the material and a seemingly endless procession of bacteria involved in the various stages of the composting process.

While the use of compost has declined steadily on farms, gardeners still consider it as one of their greatest helpers although gardening experts offer conflicting advice on how to best use it.

Basically, compost heaps do two things: they heat up to about 60° C, which kills diseases and weed seeds, and they conserve the nutrients of the original plant material.

The heat is generated by microorganisms breaking down fats to produce carbon dioxide and water. This needs oxygen, provided by raising the heap off the ground to ensure a flow of air through it.

In its second stage, the process becomes anaerobic as the bacteria involved do not need oxygen to feed on the plant nutrients.

At this stage, the heap is best buried in a pit — not only to prevent the escape of nutrients in the form of gases, but also to avoid the generally unpleasant smell of nitrogen and sulphuric compounds.

But the destruction of weeds and the conservation of nutrients are not the only advantages of composting.

Many gardeners claim that compost-grown plants are healthier than those grown with inorganic fertilizers only. This may be due to the conservation of micronutrients, such as nickel, manganese and zinc, in the compost. These materials are not replaced by conventional fertilizers.

Compost also improves the soil structure, as its fungi and bacteria form the soil particles into crumbs able to retain water better, to improve air circulation within the soil and to make soil cultivation and root penetration easier.

The microbial communities in compost also prevent the growth of disease fungi by feeding on them directly and by competing for their nutrients.

What is still a mystery is how and why composting improves the taste of the crop. Researchers have found that, for example, strawberries grown with compost have a higher sugar content than those fed inorganic fertilizers, and that compost-grown plants appear to be more resistant to wilting.

There are indications that the use of manure and compost on field crops would show at least some of the benefits observed in gardening. Britain's Agricultural Advisory Council reported to the Ministry of Agriculture that the move away from traditional manuring and the use of compost on farms has been accompanied by a gradual decline of organic matter in soils and a deterioration in soil structure. Some of these impoverished soils "cannot be expected to sustain the farming system imposed on them."

As the soil structure deteriorates, heavier and more powerful machinery is used to cultivate it, which in turn compacts the soil even more.

Holland joins acid rain fighters

After West Germany, the Netherlands has joined the ranks of the European nations fighting for a reduction of SO_2 emissions to control acidic precipitation. The Dutch minister of the environment, Pieter Winsemius, demands that SO_2 and NO_x emissions be reduced in all European countries to 30 to 25 per cent of the current levels. He is also devoted to the establishment of a standard that would be applied in all European countries.

As a first step, the minister has proposed to his legislature the reduction of the present annual limit of SO_2 emissions by 5 per cent, to 475,000 tonnes for SO_2 and 500,000 tonnes for NO_x.

Britain fears SO_2 control costs

Britain's Central Electric Generating Board claims that removal of two thirds of the sulphur dioxide coming out of the stacks of its power stations by conventional means would cost $8 billion for equipment and $ 1.4 billion yearly for the removal of waste. This would add between 10 and 15 per cent to the average hydro bill.

Meanwhile, European politicians are debating whether costs of controls should be the deciding factor in the acid rain battle. One of them compared the debate over treating flue gases with the decision many European countries had to take a century ago on the installation of sewage treatment plants. If this decision had to be made today, many would claim that it would be hopelessly uneconomic to build them.

Ministry of the Environment

Hon. Andrew S. Brandt, Minister

Brock A. Smith, Deputy Minister

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SCIENCE NORTH — a permanent science museum — is nearing completion in Sudbury. Situated on the shore of Lake Ramsey and on the fringe of the ancient rocks of the Sudbury Basin, it will offer its visitors an introduction to the natural sciences of Ontario's North.
Environment Ontario participates in the $22 million project with the exhibit of a new air quality monitoring station. The station will be fully functional and will form part of the ministry's expanded telemetered air quality index network.

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